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COMBUSTION CHARACTERISTICS OF AXIAL-INJECTION END-BURNING HYBRID ROCKETS USING LIQUID OXYGEN

Abstract

This research aims to experimentally obtain the fuel regression rate and combustion state visually of an axial-injection end-burning hybrid rocket (AIEB-HR) using liquid oxygen (LOX) as the oxidizer under high-pressure conditions. The AIEB-HR, using gaseous oxygen as the oxidizer, exhibited greater fuel regression rates and superior throttle characteristics than conventional hybrid rockets. However, liquid oxidizers are more suitable for Earth launch vehicles than gaseous oxidizers because of their high density. The presence of stabilized combustion on a circular duct with liquid oxygen using Poly Methyl Methacrylate (PMMA) as fuel has enabled the development of AIEB-HR using liquid oxygen as an oxidizer, despite the small amount of liquid oxygen evaporating.

Our research group has conducted multiple experiments using 20 mm diameter multiport fuel in a visualization combustion chamber at pressures ranging from 1 to 4 MPa, and oxidizer velocity in the port ranging from 1 to 4 m/s to obtain the fuel regression rate and combustion characteristics using special photocurable resin with high toughness (AGILISTA AR-M2). These firing test results suggested the following two points.

(1) The trend of the fuel regression rate is identical to that in our previous research with PMMA fuels. The fuel regression rate decreases with increasing liquid oxidizer flow velocity and increases approximately to the power of the combustion chamber pressure. Using the results of these experiments, we developed an efficient method for obtaining design solutions. As a result, the AIEB-HR can achieve an adequate O/F ratio with an oxidizer velocity of approximately 1 m/s, a port diameter of 0.5 mm, a fuel area function of 0.98, and a chamber pressure of 4 MPa.

(2) This experiment allowed us to visually obtain the combustion characteristics at an adequate O/F ratio, as previously noted. The results of this experiment can be used to estimate the amount of liquid

oxidizer that evaporates and determine the accurate fuel regression rate. These data are necessary to precisely examine the c* efficiency when conducting rocket-motor combustion experiments. A study will follow to evaluate the effectiveness of baffle plate improvements using the c* efficiency.